AGES 8 AND ABOVE

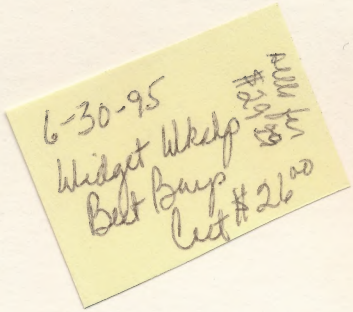
ACTIVITIES
·AND·
EXPERIMENTS

Widget WORKSHOP

THE MAD SCIENTIST'S LABORATORY

MAXIS

SOFTWARE
TOYS FOR
KIDS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Widget Wkshp
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Activities and Experiments

by
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and Michael Bremer

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Contents

Introduction 1

Distance, Speed, Time and Gravity Activities
- The Map Measurer 2
- A Light-Year Away 4
- Falling Through Space 6
- Faster Than a Speeding Bullet? 8
- Traffic Light Timer 10
- Pendulum Periods 12
- Weighing In 15
- Build a Spring Scale 17

Weather Activities
- Temperature Tracker 19
- Cricket Thermometer 21
- High As the Clouds? 23
- Lightning Distance Calculator 25
- Build a Nephoscope 27

The Human Body Activities
- Food Energy Calculator 29
- The Gene Machine 31
- Reaction Time 33
- Person Power Calculator 35
- Heartbeat Comparer 37

Sound & Light Activities
- Sending Sounds 39
- Rubber-Band Guitar Tuner 41
- Keyboard Piano 43
- Panpipes 45
- Magnifying Glass Measurer 46
- Two-Color Mixer 49
- Black + White = ? 51
- Build a Telescope 53

Numbers and Number Game Activities
- Secret Code Generator 54
- Binary Number Translator 56
- Fast Math Game 58
- Guess It Game 60

Spinning Disk Patterns 62

Introduction

Welcome to the Widget Workshop Activities and Experiments book.

What Is This Book?

This book is filled with 30 experiments and activities to help you get the most fun and learning out of Widget Workshop.

The experiments and activities cover five different subject areas:

- Distance, Speed, Time and Gravity
- Weather
- The Human Body
- Sound & Light
- Numbers and Number Games

Some of these experiments and activities are done completely on the computer using Widget Workshop. Some are done both with the computer and with off-computer objects (both the Exploration tools that come with Widget Workshop and other things you'll probably be able to find around the house. Some are done completely off the computer.

These Exploration tools are included in the Widget Workshop box, and will be used in some of the experiments:

- A Spinning Top
- A Thermometer
- A Magnifier
- A Compass
- Some Rubber Bands
- Some Straws

Before trying the activities in this book, you should already have Widget Workshop installed on your computer, and you should know how to start the program and build widgets. If you're not ready yet, then see the Quick Start Guide for installation and starting instructions and the Mad Scientist's Guide to learn how to build widgets.

The Map Measurer

This simple widget lets you use your mouse to measure the distance between two points on a map. Use it to calculate the distance of a trip before you get on the road.

Get Ready

You'll need the following item from around the house:

- Street map

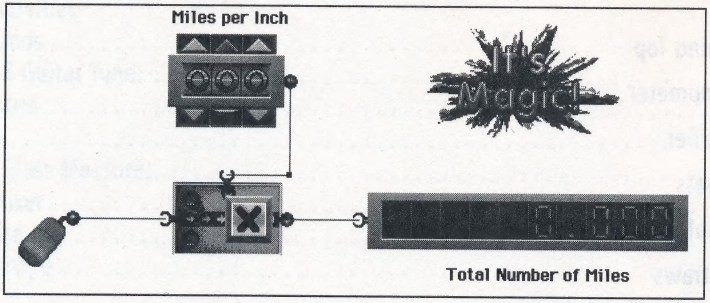
You'll need the following parts from the Tooltray:

- 1 Ten-Digit Display
- 1 Multiplier
- Labels
- 1 Three-Digit Number
- 1 Mouse Distance Measurer
- Sticker (optional)

Get Set

1. Look at the street map and find how many miles in the real world are represented by every inch on the map. Enter this number into the Three-Digit Number part by double-clicking on the part, typing in the number, and then clicking the OK button.

2. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.

2. Place the mouse on the map, so that the edge of the mouse is at the starting point of the distance you want to measure. Hold down the mouse button, and slowly move the mouse along the distance.

3. When you reach the end point, let go of the mouse button. The total distance in miles will appear in the Ten-Digit Display.

What's Going On?

The Mouse Distance Measurer takes information from the movement of the mouse and converts it into distance in inches. The widget calculates the miles using this formula:

miles traveled = miles per inch on the map x inches mouse moves.

Doc's Widget Workshop Challenge!

You've probably already figured out that you could use the Mouse Distance Measurer to measure objects around the house. Can you create a widget that uses the Mouse Distance Measurer to calculate the volume of objects around your house?

A Light-Year Away

In some science fiction shows and books, the characters talk about the number of light years between two planets. Well, you may be surprised to find out that a light year is actually a measurement of distance. Scientists use light years to measure the sizes of galaxies and the distances between stars. But just how far is a light year? Use this widget to find out!

Get Ready

You'll need the following parts from the Tooltray:

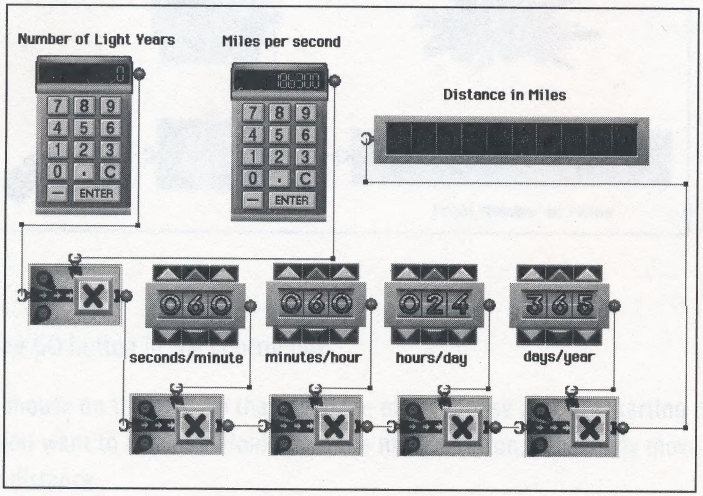
- 1 Ten-Digit Display
- 2 Numeric Keypads
- Labels
- 4 Three-Digit Numbers
- 5 Multipliers

Get Set

1. Set the Beginning Number on one of the Numeric Keypads to 186,300. You can do this by double-clicking on the part, typing in the number, and then clicking on the OK button.

2. You also need to set the numbers on the Three-Digit Number parts. Set the Beginning Number on two parts to 60, on one part to 24, and on the last part to 365. You might want to click on the Lock Number options so that the numbers can't be changed accidentally.

3. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.
2. Enter the number of light-years on the Numeric Keypad by clicking on the numbers, and then clicking on the Enter key. The distance in miles will appear on the Ten-Digit Display. Try calculating the distance in miles between the North Star (Polaris) and the Earth (300 light-years) or the size of our galaxy, the Milky Way (100,000 light-years wide).

What's Going On?

The distances in space are so large that scientists wanted an easier way to think about them. A light-year is simply the distance that light travels through space in one year. This distance is the speed of light (186,300 miles/second) times the number of seconds in a year. For instance, the light from the closest star to the Sun, Proxima Centauri, takes 4.2 years to reach Earth, so scientists say it lies 4.2 light-years away. In miles, Proxima Centauri is 25 million million miles away. It would take at least 48 million years to reach the star by car!

Doc's Widget Workshop Challenge!

The distance between the Earth and the Sun is 93 million miles. Can you design a timer that calculates the time it takes for light to travel from the Sun to the Earth?

Falling Through Space

If you dropped a rock, a book, and an apple from the top of a seven-story building, which would hit the ground first? If you said they would all reach the ground at the same time, you're right! Now you can make a widget that not only tells you how long it takes something to fall, but also the distance the object falls in that time.

Get Ready

You'll need the following parts from the Toolbox:

- 2 Ten-Digit Displays
- 1 Three-Digit Number
- 1 Multiplier
- 1 Two-Way Splitter
- Stickers (optional)
- 1 Stopwatch
- 1 Math Functions
- 3 Keypresses
- Labels

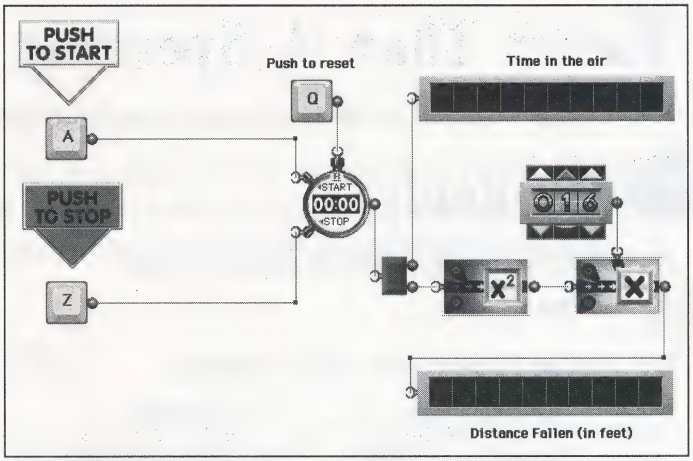
Get Set

1. We need to change the Keypress parts so that each part responds to a different letter. To do this, double-click on one of the Keypress parts. Then type the letter Z in the letter box. Then click on OK. Double-click a second Keypress part and type the letter Q in the letter box. Click on OK.

2. Next set the beginning number in the Three-Digit Number part to 16. You can do this by double-clicking on the part, typing a 16 in the Enter Beginning Number box, and then clicking on the OK button.

3. Double-click on the Math Functions part, and choose the Square function. Click on the OK button to close the window.

4. Now use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.
2. Now it's time to start the widget. Press the A key to start the Stopwatch (when an object starts falling), and press the Z key to stop the Stopwatch (when the object hits the ground). How many seconds passed between pushing the A key and pushing the Z key? How many feet would an object fall in that time?
3. Press the Q key to reset the widget, then try again. (You might want to have a friend drop something and use the widget to time how long it takes to fall. Then you can measure the distance the object fell and check it against the widget's calculation.)

What's Going On?

About 400 years ago, an Italian scientist named Galileo Galilei noticed that when an object is dropped, it speeds up, or accelerates, as it falls. This acceleration is due to a force called gravity. The pull of the Earth's gravity accelerates everything—bricks, feathers, rocks, even humans—downward at the same rate. This is called the acceleration due to gravity and is approximately 32 feet per second per second. The formula scientists use to calculate the distance an object falls in a period of time is

$$\text{distance fallen} = 1/2 \times (\text{acceleration due to gravity}) \times (\text{time in air})^2$$

Where's the acceleration due to gravity in this widget? It's the number 16 (or 32 feet per second divided by 2).

Doc's Widget Workshop Challenge!

The acceleration due to gravity is different on different planets. Can you create a widget that will show how far an object falls in a period of time on the Moon, Jupiter, or Pluto? (Hint: You might try using the Solar System part.)

Faster Than A Speeding Bullet?

How fast do you run, walk, or skip? With this widget you can easily calculate your speed in miles per hour.

Get Ready

You'll need the following items from around the house:

- Tape Measure

You'll need the following parts from the Parts Bin:

- 1 Ten-Digit Display
- 2 Three-Digit Numbers
- 1 Multiplier
- 2 Keypresses
- Labels
- 1 Stopwatch
- 1 Numeric Keypad
- 2 Dividers
- 1 Dynamite Plunger
- Stickers (optional)

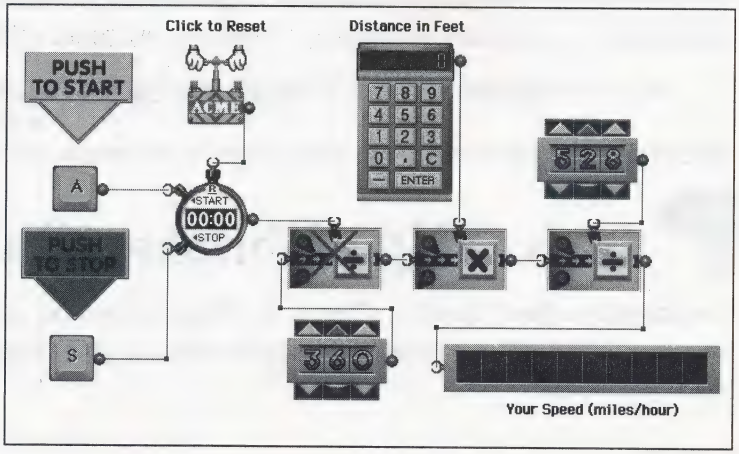
Get Set

1. To use this widget, you will be moving between two points. So pick a starting point and a stopping point. Then use the tape measure to measure the distance in feet between the two points.

2. Now let's set up the widget. Set the Beginning Number of the Numeric Keypad to show the distance you measured. Then set the Beginning Number of one of the Three-Digit Numbers to 360, and the other Three-Digit Number to 528.

3. Double-click on one of the Keypress parts and type the letter "S". Then click the OK button.

4. Now use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.
2. When you're ready, have a friend press the key A on the keyboard to start the Stopwatch. Then run, walk, or skip from the starting point to the stopping point. Your friend should stop the Stopwatch by pressing the S key when you reach the stopping point. The display shows how fast you went.

What's Going On?

When scientists watch something moving, they are interested in two things: the rate at which the object is moving, and the direction in which it moves. Speed is the rate at which the object moves—it is calculated by dividing the amount of distance covered by the time taken to cover that distance, or:

speed = distance covered / time taken to cover distance

Velocity is speed plus direction. If you told someone you walked 1 mile per hour to the north, you would be stating your velocity.

Doc's Widget Workshop Challenge!

It takes light 1.2 seconds to get from the moon to the earth—how far can you run in that same time? How far could a car go in that time if it is driving at 55 miles per hour?

Traffic-Light Timer

Use this handy timer widget to count down how long it takes for you to figure out a problem or to keep track of someone's turn in a game.

Get Ready

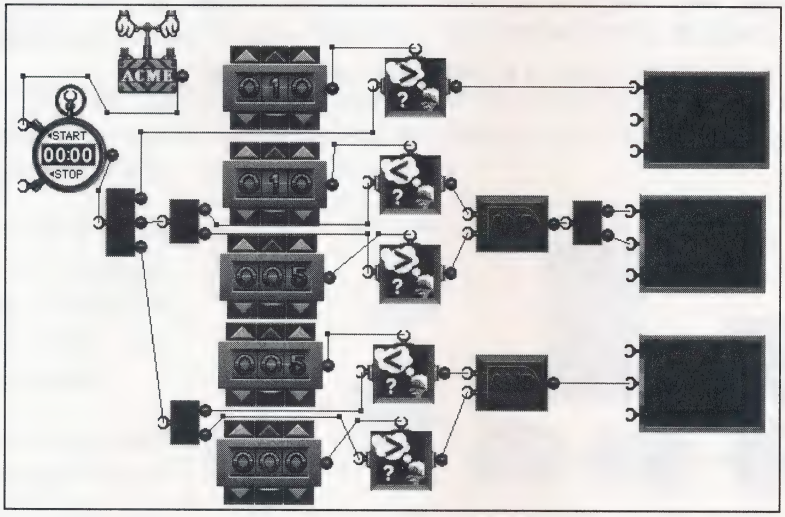
You'll need the following parts from the Parts Bin:

- 3 Color Mixers
- 5 Three-Digit Numbers
- 2 AND Logic Gates
- 3 Two-Way Splitters
- 1 Stopwatch
- 5 Comparers
- 1 Dynamite Plunger
- 1 Three-Way Splitter

Get Set

1. Set two of the Three-Digit Numbers to have a Beginning Number of 5, and two of the Three-Digit Numbers to have a Beginning Number of 10.

2. Use the mouse to arrange and connect the parts so they look like this:



Go

1. Click on the GO button in the Control box.
2. Click on the Dynamite Plunger to start the timer.

What's Going On?

This widget reads the amount of time passed on the stopwatch. If the time is between 0 and 5 seconds, the widget turns on the green light. If the time is between 5 and 10 seconds, the widget turns on the yellow light. If the time is over 10 seconds, the widget turns on the red light. The AND gates are used to tell the widget that a colored light should go on if both comparisons are true. What do you think would happen if an OR gate were used instead?

Doc's Widget Workshop Challenge!

Try changing this timer so that after the red light goes on for a period of time, the timer starts again. Or change colors of the lights that are used for the timer. Maybe shades of purple, orange, and blue would be interesting!

Pendulum Periods

Imagine you are at a playground, watching people on the swings. Can you predict how long it would take for someone to make a complete swing from front to back to front again? Do you think the weight of the person on the swing would make a difference? Do you think the length of the chain on the swing would make a difference? Here's a chance to see if you're right!

Get Ready

You'll need the following items from around the house:

- Large paper clip
- Tape
- Stopwatch or Watch
- Pen
- 6 Coins: 2 Pennies, 2 Dimes, and 2 Nickels
- Scissors
- Ruler
- Pencil

You'll need the following items from the Exploration tools:

- 2 Straws

You'll need the following parts from the Parts Bin:

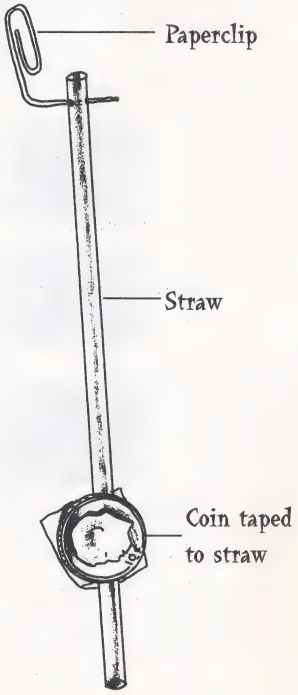
- 1 Ten-Digit Display
- 3 Numeric Keypads
- 2 Dividers
- Labels
- 1 Three-Digit Number
- 1 Multiplier
- 1 Math Function

Get Set

1. You'll be making a pendulum—a free-swinging weight—using the straws. Cut one of the straws in half. Then, use the scissors, or the end of the paper clip, to poke a hole through the end of each straw. Tape a penny to the other end of each straw.

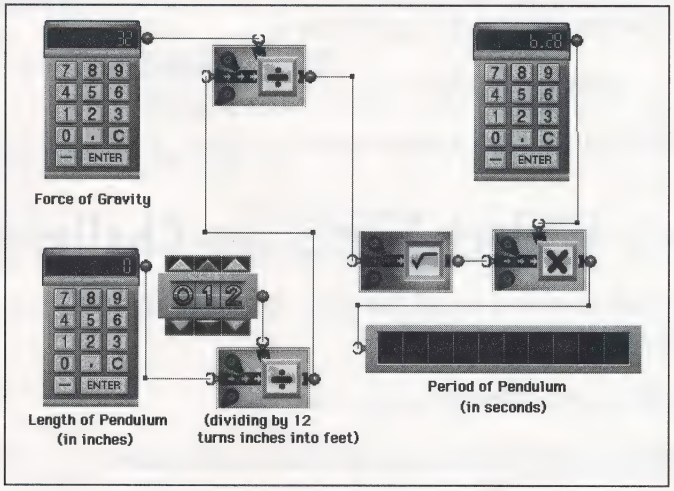
2. Straighten the end of the paper clip, then slide the longer straw over the end like this:

   The holes should be large enough so the straw can swing easily.



3. Now let's make the widget, even though you won't need it until later. Set the Three-Digit Number to 12. Then set the Beginning number of one Numeric Keypad to 32, and the other Numeric Keypad to 6.28.

4. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Hold the paper clip in one hand, and the straw of the pendulum in the other. Raise the straw so it's parallel to the floor. Then let go of the straw. Count the number of times the pendulum swings in 15 seconds. Try again, but this time tape a dime to the base of the straw, instead of the penny. Try one more time with the nickel taped to the end of the straw. Does changing the weight on the straw make a difference in the number of swings?

2. Now repeat the experiment using the shorter straw. Does changing the length of the straw make a difference in the number of swings? Does changing the weight on the shorter straw make a difference?

3. Use the widget you built to calculate the period of the pendulums you made. A period is the length of time it takes for the pendulum to make one complete swing back and forth. To use the widget, click the GO button in the Control box.

4. Measure the length of the longer straw, and enter the length into the Length of Pendulum Numeric Keypad. What is the period for this straw? Next, measure the length of the shorter straw, and enter the length into the Length of Pendulum Numeric Keypad. What is the period for this straw?

What's Going On?

In the 16th century, Galileo discovered that changing the length of a pendulum will change the length of time it takes for the pendulum to make one swing back and forth. He also discovered that changing the mass of the pendulum doesn't affect the time of the swing at all! People now use the following formula to calculate how long the period of a pendulum is:

$$\text{period of pendulum} = 2\pi \sqrt{\frac{\text{length of pendulum}}{\text{force of gravity}}}$$

In this widget, the 2π is the number 6.28, and the force of gravity is 32 feet/second^2.

Doc's Widget Workshop Challenge!

Use the Pendulum part to create a widget that shows how the changing the force of gravity affects the period of a pendulum.

What happens when you move your pendulum to the moon?

How long a pendulum do you need for a clock to tick once every second?

Weighing In

How much do you weigh on the Moon? Mercury? Saturn? Use this simple widget to find out!

Get Ready

You'll need the following items from around the house:

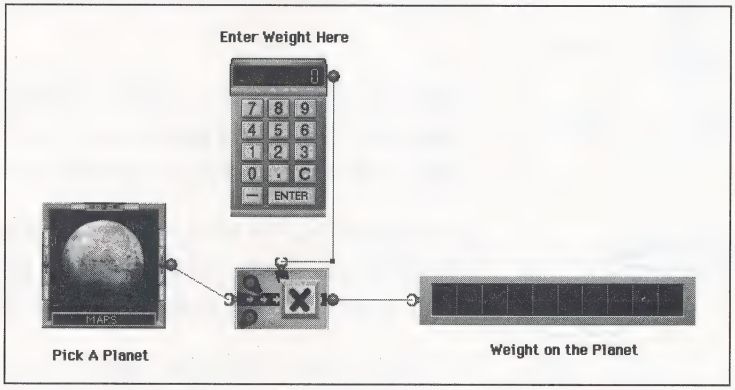
- Scale

You'll need the following parts from the Parts Bin:

- 1 Ten-Digit Display
- 1 Multiplier
- Labels
- 1 Numeric Keypad
- 1 Solar System Superpart

Get Set

1. Weigh yourself (or some other object if you wish) on the scale. Write down the weight.
2. Double-click on the Solar System part to open the information box. Choose the planet you want to use from the Planet list. Then choose Gravity from the Output list. Click on OK to close the information box.
3. Next, use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box
2. Click on the numbers on the Numeric Keypad to enter in the weight you wrote down. Then click on the Enter button to enter the number. How much would you weigh on the planet?
3. To find out your weight on other planets, click on the STOP button in the Control box. Then double-click on the Solar System part, and select a new planet from the Planet list. Click on the OK button. Then repeat steps 1 and 2.

What's Going On?

When you weigh something, you are actually measuring the force of gravity pulling that object toward the Earth. The strength of gravity is different on other planets than it is on Earth, so the weight of an object changes if you measure the weight on another planet. The mass of an object is the amount of matter an object contains. An object's mass remains the same anywhere in the universe.

Doc's Widget Workshop Challenge!

A year—that is, one trip around the Sun—on another planet is not the same amount of time as a year on Earth. Design a widget that lets you calculate how old you would be, in Earth years, at the end of a year, or twelve, or even twenty years on another planet. (Hint: Take a look at the other Output options in the Solar System part.)

Build a Spring Scale

This device lets you compare the weight of small objects, such as marbles, grapes, pencils, paper clips, or even granola.

Get Ready

You'll need the following items from around the house:

- Small Plastic Cup, such as a Yogurt Container
- String
- Nail or Thumbtack
- Tape
- Scissors
- Paper Clip
- Paper
- Ruler
- Pencil

You'll need the following item from the Exploration tools:

- Rubber Band

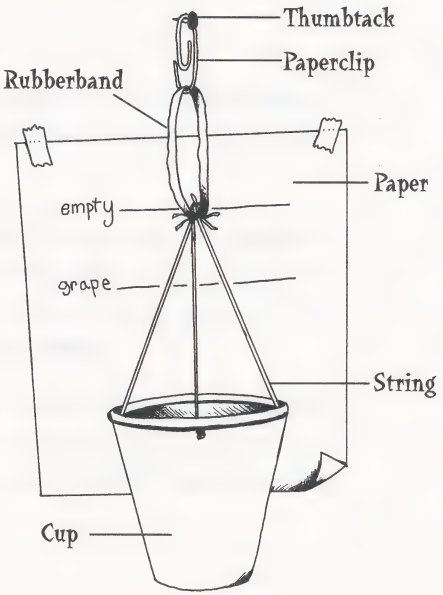
Get Set

1. Make three holes in the rim of the plastic cup. Then cut three equal-size pieces of string. Knot the end of each piece, and then thread each piece through a hole. Tie the ends of the string together to make a handle.

2. Find a vertical surface, such as a wall or bulletin board, where you can hang your balance. Then hammer the nail or press the thumbtack into the surface.

3. Slide the rubber band over the end of the paper clip, then hang the paper clip from the nail or thumbtack. Next, tie the string handle to the rubber band.

4. Tape a piece of paper behind the balance. Mark the point where the end of the rubber band hangs as your starting point.



Go

1. Place an item in the cup. Mark how far down the end of the rubber band comes on the piece of paper.

2. Try weighing other items in the cup. Compare how far down the rubber band stretches for each item.

What's Going On?

Objects have weight because gravity pulls on them. The greater the pull of gravity on an object, the more it weighs. The weight of an object inside the cup increases the downward pull of gravity on the cup, so the movement of the cup shows the relative weights of different objects. Similar types of spring balances are used in grocery stores and in meat markets.

Doc's Widget Workshop Challenge!

Rubber bands stretch evenly—a weight that's twice as heavy will stretch a rubber band twice as much. Can you make a widget that displays the weight of an object in ounces?

Temperature Tracker

A microclimate describes the average weather conditions in a very small area, such as under a tree, or in a neighborhood, or even in a room. This widget will help you find the highest, lowest, and average temperatures of microclimates around your house.

Get Ready

You'll need the following item from the Exploration tools:

- Thermometer

You'll need the following items from around the house:

- Paper
- Pen or Pencil

You'll need the following parts from the Parts Bin:

- 1 Counter
- 3 Totalers
- Labels
- 1 Numeric Keypad
- 1 Four-Way Splitter

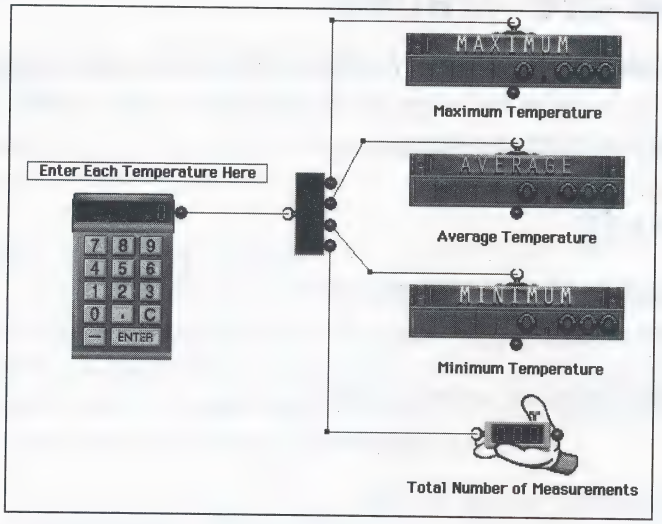
Get Set

1. Decide on several locations around your house that you will use for your measurements. You might pick some exposed spots and well as some sheltered spots. Write down on the paper the location of each spot.

2. Use the thermometer to find the temperature of each spot. First measure the temperature just above the surface of the ground. Be sure to let the thermometer sit for several minutes so you get an accurate temperature reading. Then measure the temperature 3 feet above the ground. Write down the temperatures for each location.

3. Now it's time to build the widget. Double-click on one of the Totalers, and change the Output setting to Biggest Number. Click on the OK button. Next, change the setting on the second Totaler to Running Average, and change the setting on the third Totaler to Smallest Number.

4. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Double-click on the Numeric Keypad, and type one of the temperatures you found into the Enter Beginning Number area. Click on OK.
2. Click on the GO button in the Control box.
3. Enter the rest of the temperatures, one at a time, on the Numeric Keypad. Remember to click on the Enter button after each temperature. What is the hottest temperature? What is the lowest temperature? Is the average the same or different than the individual temperatures?

What's Going On?

Climate refers to the average weather conditions of an area. An area that normally has high temperatures is said to be a hot climate, while an area that normally has low temperatures is said to be a cold climate. The temperature of a place occurs because the Sun's rays heat the air. Because the sun rays strike the ground in different places in different parts of the world, there are a variety of climates around the world. Microclimates can occur in your house for similar reasons. Often the Sun will only heat one side of the house, so that different rooms have different temperatures.

Cricket Thermometer

Did you know you can use your ears to tell the temperature? On a warm summer evening, when the crickets are chirping, use this widget to dazzle your friends.

Get Ready

You'll need the following items from around the house:

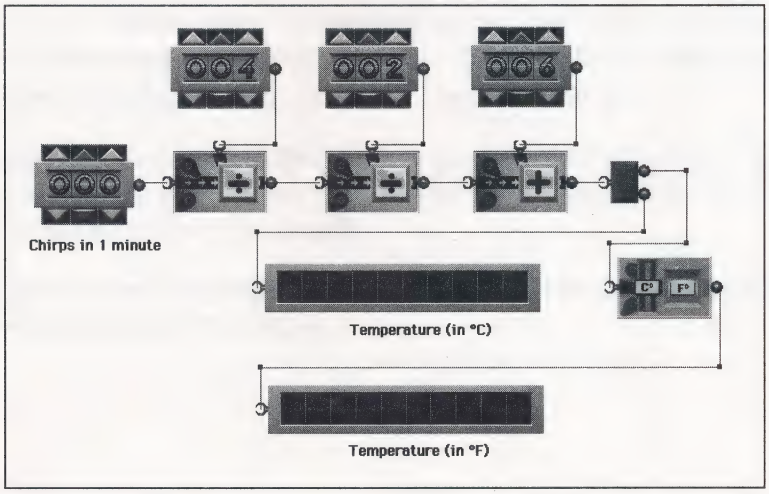
- Watch or Stopwatch

You'll need the following parts from the Parts Bin:

- 2 Ten-Digit Display
- 1 Adder
- 1 Converter
- Labels
- 4 Three-Digit Numbers
- 2 Dividers
- 1 Two-Way Splitter

Get Set

1. Set the Beginning Numbers on three of the Three-Digit Number parts so that one is set to 4, one is set to 2, and one is set to 6.
2. Double-click on the Converter, and select the °Celsius to °Fahrenheit option.
3. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. During the day or early evening, listen for the sound of tree crickets chirping. Then, using the watch or stopwatch to keep track of time, count the number of chirps you hear in one minute.

2. Click on the GO button in the Control box.

3. Enter the number of chirps you heard in the Three-Digit Number part. The Ten-Digit Displays will show the temperature in Celsius and Fahrenheit. You can prove your cricket thermometer is accurate by using the thermometer from the Exploration tools to check the outside temperature.

What's Going On?

Tree crickets are sensitive to temperature changes, and the frequency of the crickets' chirps increases as the air temperature climbs higher. Interestingly enough, only the male crickets chirp. They do this by rubbing one hard wing against the other wing, which has tiny bristles along it. The female crickets hear the sounds through "ears" on their knees.

Doc's Widget Workshop Challenge!

Instead of just showing your friends the temperature as a number, why not try making a widget that also shows the temperature as a color? (Hint: you might try using the Color Mixer.)

High as the Clouds?

Here's a way to amaze your friends and relatives—use this widget to calculate the height in the sky at which cumulus clouds (the big puffy kind) will form on any given day. To make this prediction, you'll first need to measure the dew point: the temperature at which the air can hold no more moisture.

Get Ready

You'll need the following part from the Exploration tools:

- Thermometer

You'll need the following items from around the house:

- Drinking Glass
- Water
- Ice

You'll need the following parts from the Parts Bin:

- 1 Ten-Digit Display
- 1 Three-Digit Number
- 2 Numeric Keypads
- 1 Subtractor
- 1 Multiplier
- 3 Converters
- Labels
- Sticker (optional)

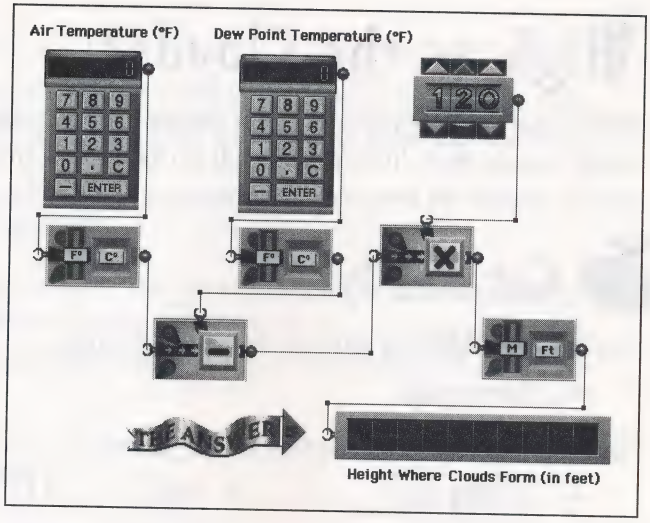
Get Set

1. Let's set up the widget first, so it will be ready when you want to try this experiment. We're going to be making measurements in degrees Fahrenheit. But we need to change this information into degrees Celsius, so we'll use Converters to do this.

2. We also want to use another Converter to change the height of the clouds, which is calculated in meters, to appear in feet. So double-click on the third converter and set the conversion to Meters to Feet, then click OK.

3. Now set the Three-Digit Number to read 120 by double-clicking on the part and typing 120 in the Enter Beginning Number area.

4. Finally, use the mouse to arrange the parts, then connect and label them so they look like this:
(You can use two labels next to each other to make a long label.)



Go

1. Use the thermometer to measure the air temperature in the empty glass. Make a note of the temperature.
2. Next, fill the glass with ice, and add just enough room-temperature water to cover the ice. Place the thermometer so it's in the glass of water, but not touching the ice.
3. Watch the outside of the glass. When you first see water begin to appear on the outside of the glass, record the temperature. This temperature is the dew point temperature.
4. Now you're ready to use your widget. Click on the GO button in the Control box.
5. Enter the air temperature on the first Numeric Keypad by clicking on each number and then pressing the Enter key. Enter the dew point temperature on the second Numeric Keypad. At what height do the clouds form?

What's Going On?

Even when it's not raining, the air often contains moisture in the form of water vapor. When the air cannot hold any more water vapor, the water condenses (changes to a liquid). The temperature at which this happens is called the dew point temperature. Warmer air can hold more water than cooler air.

Cumulus clouds form when air moves upward from the ground. As the air rises, it cools. Eventually the temperature of the air reaches the dew point, and water vapor condenses from the air to form clouds. The height at which the clouds form is calculated using the formula

height in meters = (air temperature in °C - dew point temperature in °C) x 120

Lightning Distance Calculator

If you live in an area that has thunderstorms, you may have noticed that you almost always see lightning before you hear the thunder. Now you can use this information to find out how far away the lightning bolt struck.

Get Ready

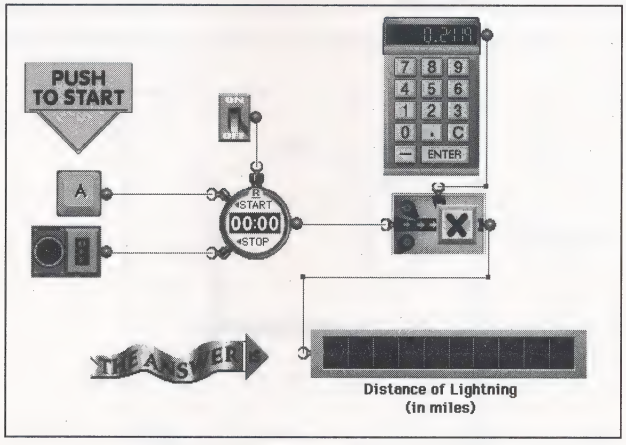
You'll need the following parts from the Parts Bin:

- 1 Ten-Digit Display
- 1 Sound Switch or other Switch
- 1 Multiplier
- 1 Keypress
- Stickers (Optional)
- 1 Stopwatch
- 1 Numeric Keypad
- 1 Light Switch
- Labels

Get Set

1. First set the Numeric Keypad so it has .2119 as the beginning number. You can do this by double-clicking on the keypad, and then typing the number in the Enter Beginning Number area. Click on the Lock Number option to prevent someone from changing the number when they are using the widget, and then click OK.

2. Now use the mouse to arrange the parts, then connect and label them so they look like this:



If you don't have a microphone for your computer, use another switch in place of the Sound Switch.

Go

1. When there's a storm nearby, click on the GO button in the Control box.
2. Press the A key as soon as you see a lightning flash. Place the computer microphone so it will pick up the sound of thunder and stop the widget when the thunder crashes. If you are using another switch, click it as soon as you hear thunder. The display will show how far away the storm is from you in miles.

What's Going On?

A lightning bolt heats the air along its path, causing the air to expand. This expansion causes vibrations that are heard as thunder. Although both the lightning flash and thunder take place at the same place, you see the lightning before you hear the thunder because light travels faster than sound. (Light travels at a speed of 186,000 miles per second (300,000 kilometers per second), while sound travels at only about .2119 miles per second (or 340 meters per second).) So if you count the number of seconds from the time you see the lightning to the time you hear the thunder, and divide this time by the speed of sound, you will know how far away you are from the storm.

Doc's Widget Workshop Challenge!

How can you find out whether a storm is approaching or moving away? Try creating a widget that determines whether the storm's distance is increasing or decreasing.

Build a Nephoscope

You probably already know that wind vanes can be used to determine wind direction on the ground. But meteorologists also look at the wind direction at cloud height. Now you can make a device, called a nephoscope, that lets you do this too.

Get Ready

You'll need the following item from the Exploration tools:

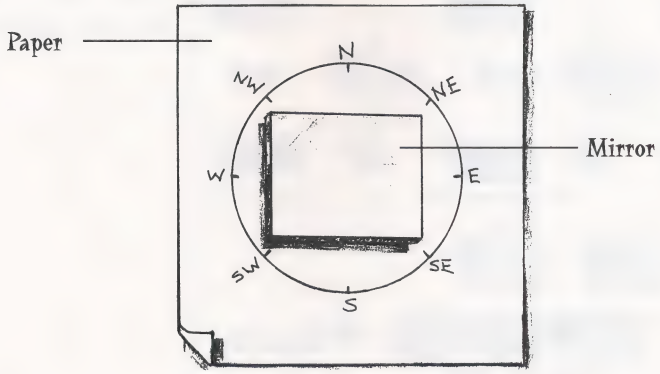
- Compass

You'll need the following items from around the house:

- Small Hand Mirror
- Compass or Bowl
- Pen or Pencil
- Paper

Get Set

1. Make a large circle on the paper using a compass or by tracing around the edge of a bowl. The circle should be large enough to fit the mirror inside of it.
2. Mark the eight compass points (N, NE, E, SE, S, SW, W, NW) around the edge of the circle.
3. On a day when there are separate clumps of moving clouds in the sky, go outside and place the paper on a flat surface such as the ground or a table. Then use your compass to determine the direction of north. Turn the paper so that the N marking on the paper faces north. Place the mirror inside the circle. Your nephoscope is ready to use.



Go

1. To use the nephoscope, look in the mirror and follow the image of a cloud as it moves across the mirror and past the edge of the mirror's surface. The point on the nephoscope where you first see the cloud image appear, indicates the wind direction. For example, if you see a cloud appear at the western point and move toward the eastern point, the wind is coming from the west.

2. Try watching several different clouds. Are all the clouds the same type? If not, how would you describe the different clouds? How do they change and move across the sky? Do all the clouds move in the same direction? Do all the clouds move at the same speed?

What's Going On?

The winds at cloud height, called high-altitude winds, do not always blow in the same direction as surface winds. The direction and speed of winds at ground level are affected by obstacles such as hills, trees, and buildings, while the direction and speed of winds at cloud level tend to be consistent and have a definite direction. High-altitude winds are also stronger than surface winds. The nephoscope makes it easy to track the direction of cloud movement, which in turn, makes it easy to determine the direction of the wind. Meteorologists also use weather balloons to determine the direction of high-altitude winds.

Food Energy Calculator

Have you ever wondered how scientists find the number of calories in a slice of chocolate cake? Or in the double-cheese burger you had for lunch? Believe it or not, they burn the food to see how much heat is produced. Luckily, scientists have burned a lot of food over the years, so you don't have to. Instead you can create this handy calculator to decipher food labels and to figure out the number of calories you get from the protein, fat, and carbohydrates in the food you eat.

Get Ready

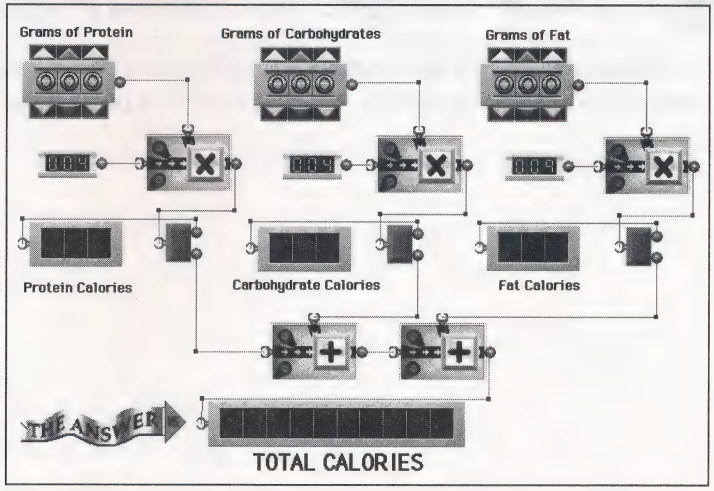
You'll need the following parts from the Parts Bin:

- 1 Ten-Digit Display
- 3 Three-Digit Numbers
- 2 Adders
- Labels
- 3 Three-Digit Displays
- 3 Multipliers
- 3 Two-way Splitters
- Sticker (optional)
- 3 Mini Three-Digit Numbers

Get Set

1. First let's preset the numbers for the Mini Three-Digit Number parts. Double-click on a Mini Three-Digit Number part and set the Beginning Number to 4, and click OK. Now, do the same with a second Mini Three-Digit Number part. Then set the third Mini Three-Digit Number part so it has a beginning number of 9.

2. Now use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.
2. Look for the Nutrition Facts label on a food can, box, or bag from your kitchen. See the entries for Total Fat, Protein, and Total Carbohydrate? Next to each entry you'll see the amount of each in grams. Enter the number of grams for each by clicking on the up and down arrows on the appropriate Three-Digit Number part.
3. Take a look at the total number of calories the widget calculated. Is it the same as the number of calories listed on the food container? Also check out the total number of Calories from fat. Do most of the calories in the food come from fat? You might want to keep a list of what you eat for a day to find out.

What's Going On?

You probably already know that you burn food in your body to get the energy you need to live. When you calculate the number of calories in a serving of food, you're calculating the amount of energy stored in that food. If you're like most kids, you need about 2,400-2,800 calories a day to provide energy for your growing body. But you also need nutrients, and that's where the difference between calories from fat, protein, and carbohydrates comes in. Carbohydrates, protein, and fat all are considered nutrients. Each provides a different type of energy source for your body. Nutritionists suggest that most of your calories should come from carbohydrates and proteins, rather than fat.

Doc's Widget Workshop Challenge!

Nutritionists recommend that no more than 20% of your daily calories come from fat. Design a widget that will calculate the percentage of calories from fat in the food you eat.

The Gene Machine

Why do people look different from one another? Because many of their physical features are determined by the genes they receive from their parents. For many physical traits, such as hair color or eye shape, each person gets a single gene from each parent. Since there are thousands of genes that determine what a person looks like, there are millions of possible combinations! This widget lets you randomly combine genes to create features for a made-up face.

Get Ready

You'll need the following parts from the Parts Bin:

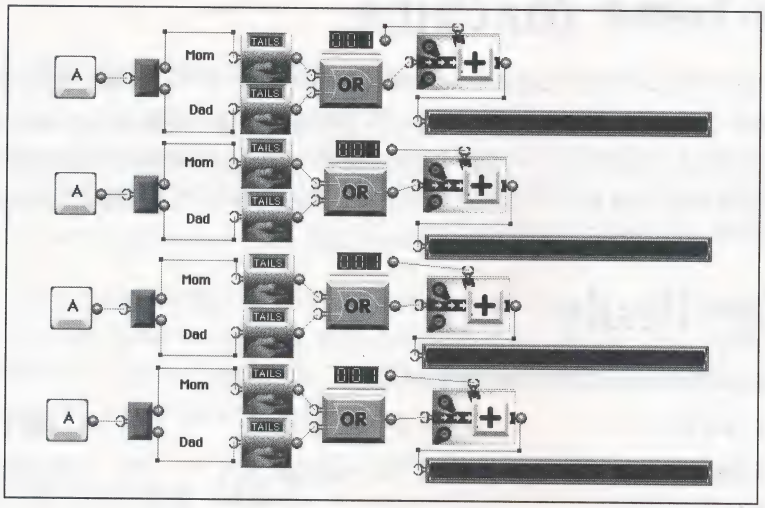
- 8 Coin Toss
- 4 Keypresses
- 4 Message List
- 4 OR Logic Gates
- 4 Two-way Splitters
- Labels
- 4 Adders
- 4 Mini Three-Digit Numbers

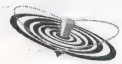
Get Set

1. So, what do you want your genes to be? Decide on four features, such as eye color, hair color, face shape, eye shape, ear shape, or nose shape. Then for each feature, choose two possible traits. For example, let's say you choose face shape as one feature. One possible trait could be a square shape, while the other trait could be a round shape.

2. Now let's enter your features into the Message List parts. You'll use one Message List for each feature. Double-click on one of the Message List parts. In the area that says 1, type in one of the possible traits for a feature. In the area that says 2, type in the other trait for that feature. Then click on the OK button to close the information box. Repeat for the other Message List parts.

3. Use the mouse to arrange the parts, then connect and label them so they look like this:





Go

1. Click on the GO button in the Control box.

2. Press the A key on the keyboard to start the machine. What features does your made-up face have? Press the key again to create a new face. Does it have the same features?

What's Going On?

If you look around at people, you may notice that some traits seem to appear more often than other traits. For example, dark hair color tends to be more common than light hair color. This occurs because some traits are dominant and some are recessive. When a person inherits a dominant trait, the person shows that trait regardless of whether the gene is paired with another dominant gene or a recessive gene. But in order for a recessive trait to show up, the gene must be paired with another recessive gene.

These are the three possible pairings of dominant and recessive genes:

Dominant Trait + Dominant Trait = Dominant Trait Shows Up

Dominant Trait + Recessive Trait = Dominant Trait Shows Up

Recessive Trait + Recessive Trait = Recessive Trait Shows Up

The traits you entered in Line 1 were recessive traits, and the traits you entered in Line 2 were dominant traits. The OR Logic Gates in the widget made sure that the recessive traits only appeared when both the Mom and the Dad genes were recessive.

Reaction Time

Imagine that you're strolling down the street and you hear a noise. You look up and see a ball coming straight toward you. How quickly can you react? Use this widget to test your reaction time.

Get Ready

You'll need the following parts from the Parts Bin:

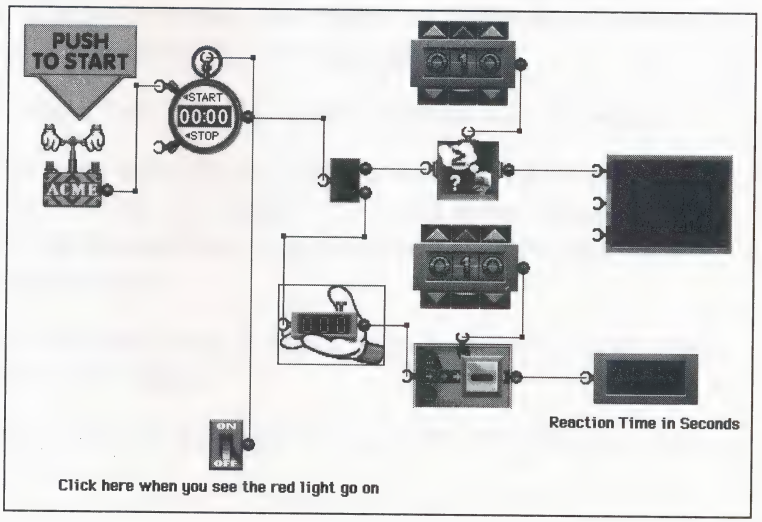
- 1 Color Mixer
- 1 Stopwatch
- 1 Counter
- 1 Comparer
- 1 Dynamite Plunger
- Labels
- 1 Three-Digit Display
- 2 Three-Digit Numbers
- 1 Subtractor
- 1 Light Switch
- 1 Two-way Splitter
- Stickers (optional)

Get Set

1. First set the Beginning Numbers on the Three-Digit Number parts to 10. To do this, double-click on a Three-Digit Number part , type in the number 10, and then click on the OK button.

2. Next, set the Comparer by double-clicking on it to bring up the information box. Choose the Greater Than or Equal To option, and then click on the OK button.

3. Now use the mouse to arrange the parts, then connect and label them so they look like this:
(Use two labels next to each other to make the long label.)



Go

1. Click on the GO button in the Control box.
2. Click on the Dynamite Plunger to start the timer. As soon as the red light appears, click on the Light Switch to stop the widget. Your reaction time will appear in the Three-Digit Display. How fast was your reaction time? Try again to see if you get better with practice. How does the reaction time of your right hand compare to your left hand?

What's Going On?

The time between when your body senses something—for example, when your eyes see the red light and send that information to your brain—and when you actually act—when your finger presses the mouse button—is called the reaction time. Different people have different reaction times. And individuals can also react more or less quickly to different types of signals.

Doc's Widget Workshop Challenge!

Do you think your reaction time would be slower, faster or the same if the cue for clicking the mouse button were sound rather than sight? Design a widget to find out!

Person Power Calculator

How powerful are you? You may be surprised by the answer! This handy widget lets you find out how much power you generate when walking up stairs.

Get Ready

You'll need the following items from around the house:

- Tape Measure
- Scale

You'll need the following parts from the Parts Bin:

- 1 Strip Chart
- 1 Stopwatch
- 2 Multipliers
- 2 Converters
- 1 Two-way Splitter
- 1 Ten-Digit Display
- 3 Numeric Keypads
- 1 Divider
- 2 Keypresses
- Labels

Get Set

1. You'll need a couple of numbers before you get started. First, use the tape measure to measure the vertical height of the stairs. The vertical height is the vertical distance between the bottom and top of the stairs. You can find this by measuring the height from the bottom of one stair to the bottom of the next. Then multiply this number by the number of stairs in the staircase. The total will be the vertical height of the stairs.

2. You'll also need your weight. Step on a scale, and write down how much you weigh.

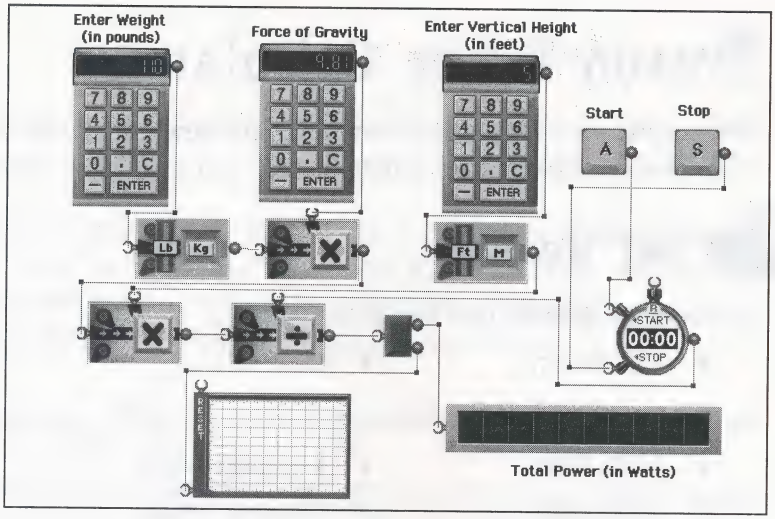
3. Now you're ready to set up the widget. Set the Beginning Number of one Numeric Keypad to show your weight, set the Beginning Number of the second Numeric Keypad to show the vertical height of the stairs, and set the Beginning Number of the third Numeric Keypad to 9.81 (the force of gravity).

4. Next set the converters. One should be set to convert Pounds to Kilograms, and the other should be set to convert Feet to Meters.

5. Double-click on the Strip Chart and set the Number Range to 0 to 1000, then click on the OK button.

6. Finally change the Keypress parts so that each has a different letter.

7. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.

2. When you're ready, have a friend press the key on the keyboard to start the stopwatch. Then run up the stairs. Your friend should stop the stopwatch when you reach the top. The display shows how much power you generated. How did you do? The strip chart shows the amount of power generated over time. You might try again to see if your power decreases after several runs.

What's Going On?

Power is really a measure of the rate at which work is done. But work has a special meaning in science—it means the amount of force (or effort) required to move an object multiplied by the distance the object moves. In this case the object is you. Your power was measured in watts. How powerful are you compared to some of these other objects?

Car engine	200,000 watts
Computer	50 watts
Light bulb	100 watts
Hair dryer	1000 watts
Washing machine	375 watts

Heartbeat Comparer

What's the strongest muscle in your body? Your arm? Your leg? No, it's your heart! Now you can use this widget to compare your heartbeat rate to those of adults, babies, even cats, dogs, and elephants!

Get Ready

You'll need the following item from the Exploration tools:

- Rubber Band

You'll need the following items from around the house:

- About 12 inches of Rubber Tubing
- Balloon
- 2 Small Funnels
- Scissors

You'll need the following parts from the Parts Bin:

- 2 Three-Digit Displays
- 1 Animal Sounds
- 4 Three-Digit Numbers
- 2 Multipliers
- 1 Mouse Click
- 1 Mini Three-Digit Number
- 3 Two-way Splitters
- 1 Heart
- 1 Stopwatch
- 1 Speaker
- 1 Counter
- 2 Comparers
- 1 Message List
- 1 Switcher
- 1 Totaler
- 1 Adder
- Labels

Get Set

1. Start by making a stethoscope so you can listen to the sounds of your own heart. To do this, cut the balloon and stretch a piece tightly over one of the funnels. Use the rubber band to hold it in place. Then fit the ends of the tubing over the spouts of the funnel. Now you have your stethoscope!

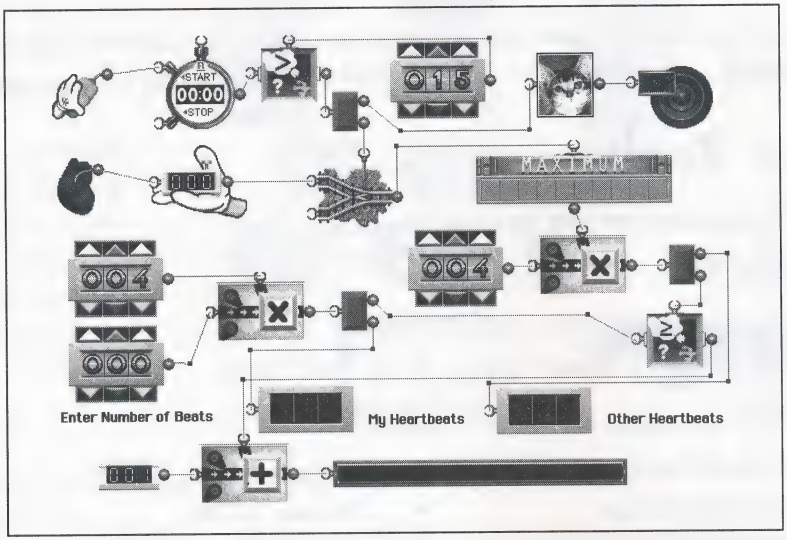
2. Now let's put together the widget. First, set the Beginning Number for two of the Three-Digit Number parts to 4. Then set the Beginning Number for another Three-Digit Number piece to 15. Set the Mini Three-Digit Number to 1.

3. Next, change the Totaler output to Biggest Number so it will calculate the maximum.

4. Set one Comparer to "Greater Than" and the other to "Greater Than or Equal To."

5. Double-click on the Message List part. For the first line type in "My heartbeat is slower." For the second line type in "My heartbeat is faster." Click on the OK button to close the information box.

6. Now use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Double-click on the Heart part. Then select one of the Whose Heart options. Make sure the output is set to On During Heartbeat. Then click the OK button.

2. Hold the stethoscope with one funnel next to your ear, and the second funnel over your heart. You should be able to hear a low lub-dub sound. This is your heartbeat.

3. With the stethoscope still over your heart, click on the GO button, then quickly click the mouse again to start the stopwatch.

4. Count the number of lub-dubs you hear in 15 seconds. (You'll know when the time is up when you hear the cat meow.) Enter this number in the fourth Three-Digit Number part by clicking on the arrows. The number of beats per minute will show up in the two Three-Digit Displays, and a message will come up to tell you whether your heartbeat is faster or slower than the heartbeat you picked!

What's Going On?

The lub-dub sound you hear is the sound of your heart valves closing and opening. The longer lub sound is made when blood flows out of the heart and two heart valves shut. The shorter dub sound is made when two other heart valves open, and blood flows into the heart.

Sending Sounds

If someone made a noise 100 feet away from you, would you hear the noise the instant it was made? What if the sound were made at the other end of a huge piece of wood or metal? This widget lets you calculate how quickly a sound would reach your ears if it were transmitted through different types of material.

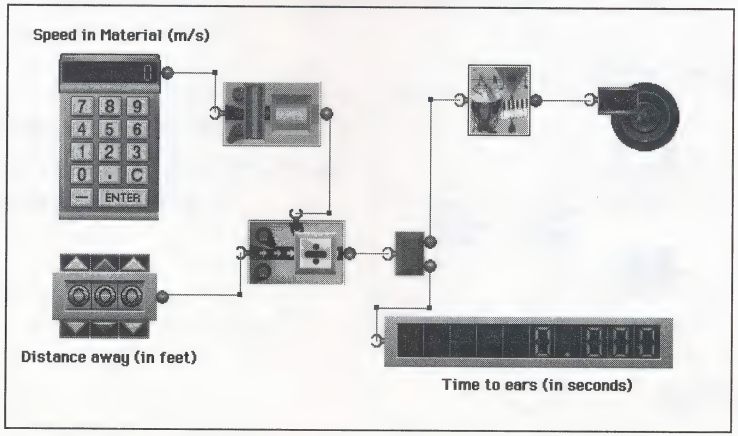
Get Ready

You'll need the following parts from the Parts Bin:

- 1 Ten-Digit Display
- 1 Numeric Keypad
- 1 Three-Digit Number
- 1 Converter
- Labels
- 1 Assorted Sounds
- 1 Speaker
- 1 Divider
- 1 Two-way Splitter

Get Set

1. Decide how far away (in feet) the sound will be from your ears. Enter that number in the Three-Digit Number part.
2. Choose a sound from the Assorted Sounds part by double-clicking on the part, and then selecting a sound from the list. Click on the OK button when you've made your choice.
3. Double-click on the Converter, and choose the Meters to Feet option. Then click on the OK button.
4. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.
2. Type in one of the following speeds in the Numeric Keypad:

Material	Speed (m/s)
Air	340
Helium	961
Water	1500
Marble	3810
Oak	3850
Aluminum	5000
Iron	5120

3. Press the Enter key after typing in the number. The time it would take the sound to reach you in seconds will appear on the display. How soon will the sound reach your ears if it travels through wood? Through water? Through iron?

What's Going On?

Sound travels in waves, similar to the waves you make if you drop a pebble in a pond of water. The sound waves travel from the sound source to your ears by vibrating tiny particles called molecules. The molecules in different materials are packed together in different ways. In some materials, such as air, the molecules are loosely packed, while in other materials, such as wood and metal, the molecules are more tightly packed. Sound waves move more easily through the more tightly packed molecules, so they move more quickly through materials such as aluminum and iron.

Rubber-Band Guitar Tuner

Make your own musical instrument, and then use this widget to find out what notes you can play.

Get Ready

You'll need the following items from around the house:

- Tissue Box
- Scissors
- 3-4 Rubber Bands of different lengths and thicknesses
- 2 Pencils

You'll need the following item from the Exploration tools:

- Rubber Bands

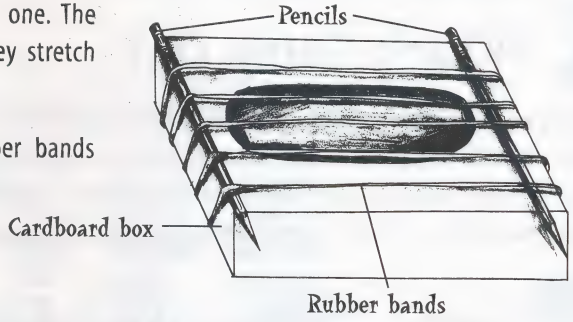
You'll need the following parts from the Parts Bin:

- 1 Tuning Fork
- 2 Speakers
- 1 Two-way Splitter
- 1 Recorder
- 1 Keypress

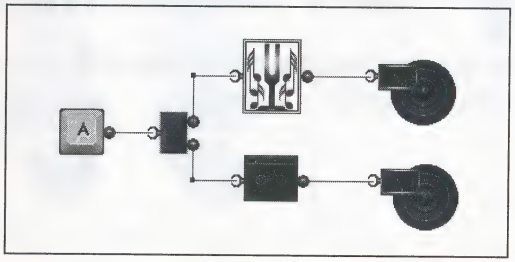
Get Set

1. First let's build the rubber band guitar. Stretch the rubber bands across the top of the box, leaving about 1/2" between each one. The bands should be positioned so they stretch across the hole in the box.

2. Place the pencils under the rubber bands near the edges of the box, like this:



3. Now let's build the tuner widget. Use the mouse to arrange the parts and connect them so they look like this:



Go

1. Double-click on the Recorder, and then click on the Record a Sound button. Place the computer's microphone near your guitar. Then click on the Record button in the dialog box. Pluck one string on your guitar. Then click on the Stop button. Next, click on the Save button, and then on the OK button.

2. Now double click on the Tuning Fork part. Choose an Output Frequency that you think might be close to the sound of the note you just recorded. Then click on the OK button.

3. Click on the GO button in the Control box.

4. Press the A key on your keyboard. You'll hear both the note from your guitar and the note on the tuner. How close are they? Press the STOP button in the Control box, and choose a different Output Frequency. Then press the GO button to try again.

5. Keep trying different notes until you find one that's close to the note you made with your guitar. (Hint: you can adjust the note on your guitar by gently moving one of the pencils to stretch the rubber band slightly.) When you find the matching note, write it down for later use.

6. Record the sounds made by the other rubber bands on your guitar, and try to find the matching notes with the Tuner. Which rubber bands made the highest notes? Which rubber bands made the lowest notes?

What's Going On?

When you pluck a rubber band, the vibrations in the band cause the box and the air inside it to vibrate. This vibration causes the sound you hear. Slower vibrations give a lower sound or pitch. Faster vibrations give a higher sound or pitch. The pitch of a sound is measured in hertz (Hz). If you look at the Output Frequency options in the Tuning Fork part, you'll see that next to each note is the pitch of that note.

Doc's Widget Workshop Challenge!

What are the highest and lowest pitches you can hear? Use the Tuning Fork's Custom Output Frequency option to find out!

Keyboard Piano

Want to play music on your computer? This widget makes it possible by turning part of your computer keyboard into a musical instrument!

Get Ready

You'll need the following parts from the Parts Bin:

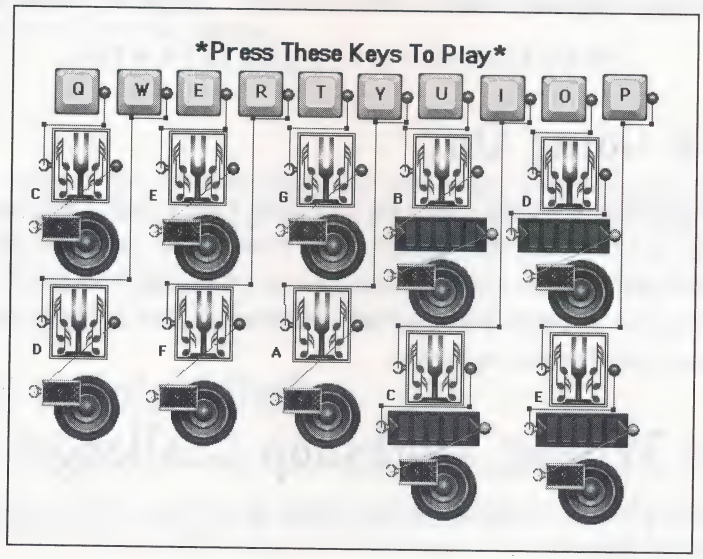
- 10 Tuning Forks
- 4 Sound Transformers
- Labels
- 10 Speakers
- 10 Keypresses

Get Set

1. Double-click on each Keypress part and type in a letter from the top row of letters on your keyboard (Q, W, E, R, T, Y, U, I, O, P).

2. Now double-click on a Sound Transformer. Click on the Transform Sound option, and then click the Change Pitch option. Choose the Up An Octave setting from the option list. Then click on the OK button. Repeat for the other three Sound Transformers.

3. Use the mouse to arrange the parts, then connect and label them so they look like this:



4. Now let's set the notes on the piano. Double-click on the first Tuning Fork (the one attached to the Keypress with a Q in it). Choose the C pitch from the list of options, then click on the OK button to close the information box. Repeat for each Tuning Fork using this chart:

Attached to this Keypress	Use this Note
Q	C
W	D
E	E
R	F
T	G
Y	A (440 Hz)
U	B
I	C
O	D
P	E

Go

1. Click the GO button in the Control box.
2. Press a letter key in the top row of your keyboard. What note do you hear? Try pressing several letter keys at once. You've just made a chord!
3. Make up songs to play using your keyboard piano. Here's a simple one for you to try:

E W Q W E E E W W W E T T E W Q W E E E E W W E W Q

What's Going On?

Pianos are string instruments. When you press a key on a piano, a piece called a hammer hits the corresponding string, causing it to vibrate. This vibration creates a sound. What you've actually created on the computer is a form of piano called a synthesizer. Synthesizers are piano-like keyboards connected to a small computer. A musician playing a synthesizer can send information to the computer so it produces certain types of sound when the keys are pressed.

Doc's Widget Workshop Challenge!

Can you make another piano that produces different pitches of cat meows? Or what about a piano that uses your voice for each note?

Panpipes

Panpipes are a form of instrument that has been used for thousands of years by people in many different parts of the world. Now you can make you own!

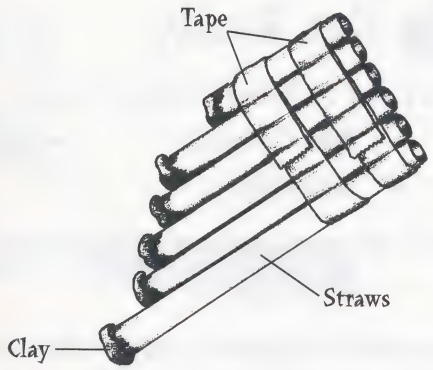
Get Ready

You'll need the following items from around the house:

- Scissors
- Modeling Clay or Tissue Paper
- Tape
- Ruler

You'll need the following item from the Exploration tools:

- Straws



Get Set

1. Cut the straws into five or six pieces that vary in length between 2 1/2 inches and 6 inches.
2. Push a small piece of modeling clay into the end of each straw to seal the end. If you don't have any clay available, wad up pieces of tissue paper and use them to seal the ends.
3. Arrange the straws in order of length, then tape the straws together so that the open ends are level with each other, like this:

Go

1. To play your panpipe, place the edge of the open end of the pipe against your lower lip and blow gently across the top of the pipe. It may take a little practice to get it right.
2. What happens when you blow across the longer straws? What happens when you blow across the shorter straws? Can you create a song using the pipes?

What's Going On?

When you blow across the top of the straws, you vibrate the air inside the straw. This vibration produces the sound your hear. The more air inside the straw, the slower it vibrates and the lower the sound. That's why longer straws have lower-pitched notes and shorter straws have higher-pitched notes.

Magnifying Glass Measurer

You may already know that a magnifying glass makes small objects look larger. But did you know that you can also use a magnifying glass to measure the distance between the glass and an object? This widget makes it easy!

Get Ready

You'll need the following items from around the house:

- White Cardboard
- Ruler
- Lump of Clay

You'll need the following item from the Exploration tools:

- Magnifying Glass

You'll need the following parts from the Parts Bin:

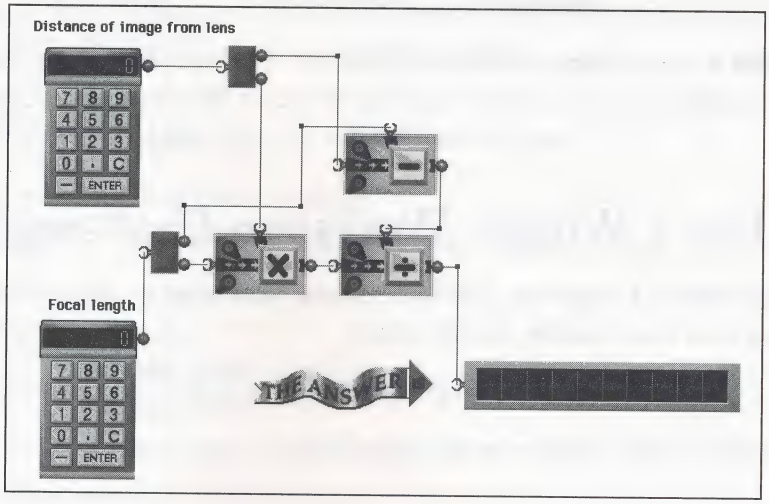
- 1 Ten-Digit Display
- 2 Numeric Keypads
- 1 Subtractor
- 1 Multiplier
- 1 Divider
- 2 Two-way Splitters
- Labels
- Sticker (optional)

Get Set

1. To make the measuring device, you first need to know the distance between the magnifying glass and the sharpest image it can make. This distance is called the focal length of the magnifying glass. To find the focal length, start in a room that has only one source of light, such as a lamp or a sunlit window. Stand at least five feet away from the light source and hold the magnifying glass so it's facing the light. Hold the cardboard with your other hand so it's on the other side of the glass. You should see some light on the cardboard. Move the cardboard back and forth until you see the sharpest point of light possible on the cardboard.

2. When you have found the position where the light point is the sharpest, use the ruler to measure the distance between the magnifying glass and the cardboard. This is the approximate focal length of the magnifying glass lens.

3. Now build the widget. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. To use your magnifying glass measurer, find an object near a bright light source. Hold up the cardboard to use as a screen, and then hold the magnifying glass so it's between the cardboard and the object. Move the glass back and forth until you get a clear image of the object on the screen. Then measure the distance between the cardboard and the glass. This is your image distance.

2. Click on the GO button in the Control box.

3. Enter the focal length of the magnifying glass. You should make it a negative number by pressing the minus key on the Numeric Keypad before you press the Enter key.

4. Enter the image distance. The approximate distance of the real object from the magnifying glass will appear in the Ten-Digit Display! If you want, you can check to see if it's correct using your ruler.

What's Going On?

The lens of the magnifying glass takes light that's shining or reflecting off an object and bends it so that it all comes back together at one spot. When the light comes together, it forms an image of the object.

Scientists have found out that the formula that relates the focal length, object distance, and image distance is:

$$\frac{1}{\text{image distance}} + \frac{1}{\text{object distance}} = \frac{1}{\text{focal length}}$$

If the image is upside down, a negative number is used for the image distance. If the image is right-side up, a positive number is used for the image distance. In the widget you built, the equation has been rearranged to find the object distance.

Doc's Widget Workshop Challenge!

The magnification of a magnifying glass tells you how much larger an image will be when it's seen through the glass. The formula for magnification is:

$$\text{magnification} = -\frac{\text{image distance}}{\text{object distance}}$$

Design a widget that will calculate the magnification of your glass for you!

Two-Color Mixer

Did you know that all the colors you see on your TV or computer screen are made by mixing only three colors—red, blue, and green? This widget lets you see how this works.

Get Ready

You'll need the following items from around the house:

- White Paper
- Scissors
- Red, Blue, and Green Markers
- Compass (the kind you draw circles with)
- Pencil

You'll need the following item from the Exploration tools:

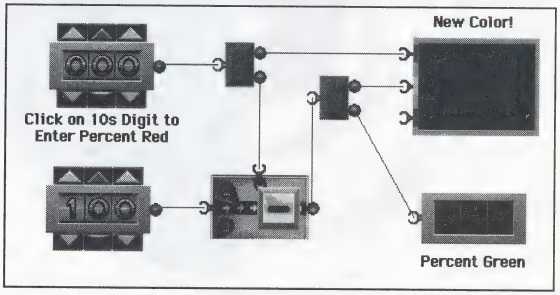
- Wood top

You'll need the following parts from the Parts Bin:

- 1 Color Mixer
- 2 Three-Digit Numbers
- 2 Two-way Splitters
- 1 Three-Digit Display
- 1 Subtractor
- Labels

Get Set

1. Use the compass to make six or seven 3-inch circles on white paper. Cut out the circles to use later.
2. Set the Beginning Number of one of the Three-Digit Numbers to 100.
3. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.
2. Use a number between 0 and 100 for the Percent Red. You'll see a color appear on the Color Mixer.
3. Next use the red and green markers to color in different portions of the white paper disk to match the percentages on the screen. For example, if you have 50% red, and 50% green showing on the screen, you should color one half of the disk red, and the other half green.
4. Use the pencil to make a hole in the center of the paper disk. Put the disk on the top, color-side up. Then spin the top. What color do you see? Does the color match the color on the screen? Do you get the same color if you mix the red and green marker directly on the paper?
5. Try different amounts of red and green to see what happens. You might also try changing the connections to the Color Mixer to try combinations of red and blue, or blue and green.

What's Going On?

White light, which is sunlight or the light from an electric light bulb, appears colorless. But it is really made up of a mixture of red, blue, and green. Varying the proportions of these three colors produces all the other colors. When the top is spinning quickly, your eyes cannot see each color separately, so the colors merge together.

Doc's Widget Workshop Challenge!

How can you use the red, green, and blue markers and the top to produce a white or gray color?

Black + White = ?

The top in your Exploration tools can be used to create a device called Benham's disk. Behham was a toy-maker who lived in the 18th century. He created a black and white pattern that could be spun on a top to create colors!

Get Ready

You'll need the following item from around the house:

- Scissors

You'll need the following items from the Exploration tools:

- Wooden Top
- Benham Disk Pattern

Get Set

1. Make a copy of the Benham disk pattern below, and cut it out.
2. Cut out the hole in the center of the pattern, and then place the pattern on top of the top.

Go

1. Spin the disk under a bright light. What colors do you see? What order are they in?
2. Try watching the top as it spins at different speeds. Is it easier to see the colors when the top is spinning more quickly or more slowly?

What's Going On?

You have three types of color receptors in your eyes. Each type is sensitive to a different color of light. These receptors also behave differently when hit by light. Some, such as the receptors that respond to the color blue, take a longer time to send signals to your brain. Others, such as the receptors that respond to the color green, take longer to stop sending signals to your brain.

Normally white light sends an equal signal to all three types of receptors. But when the top spins it sends flashes of white so quickly that the slower color receptors in your eyes can't keep up with the faster color receptors. As a result, your color receptors don't respond to the light equally so that instead of seeing white, you see colors.

Doc's Widget Workshop Challenge!

There are other spinning disk patterns at the back of this book. Make copies of them, cut them out, and see what colors they create.

Build a Telescope

How can you make the moon look larger using a magnifying glass? How about using the magnifying glass and a couple of mirrors to make your own telescope!

Get Ready

You'll need the following items from around the house:

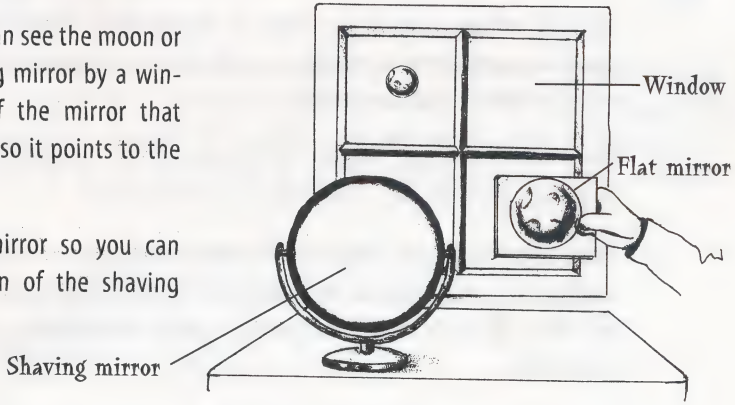
- Shaving (magnifying) Mirror
- Small, flat Mirror

You'll need the following item from the Exploration tools:

- Magnifying Glass

Get Set

1. On a night when you can see the moon or stars, place the shaving mirror by a window. Turn the side of the mirror that gives the larger image so it points to the moon or stars.
2. Hold the small flat mirror so you can clearly see a reflection of the shaving mirror in the middle.



Go

1. Look at the reflection in the flat mirror using the magnifying glass. What do you see?
2. Try changing the positions of the mirrors. Does it change what you see? How?

What's Going On?

The telescope you created is called a reflecting telescope because it uses mirrors to reflect light. In a reflecting telescope, light rays from a distant object reflect off the large mirror onto the smaller mirror, which in turn sends the light to a small lens. The lens, which is similar to a magnifying glass lens, makes the image look larger. The first reflecting telescope was made by Sir Isaac Newton in the mid-17th century.

Secret Code Generator

Use this widget to translate letters into a picture code. Then use the code to send secret messages to friends!

Get Ready

You'll need the following parts from the Parts Bin:

- 2 Graphic Projectors
- 1 Divider
- Labels
- 2 Three-Digit Numbers
- 1 Two-way Splitter

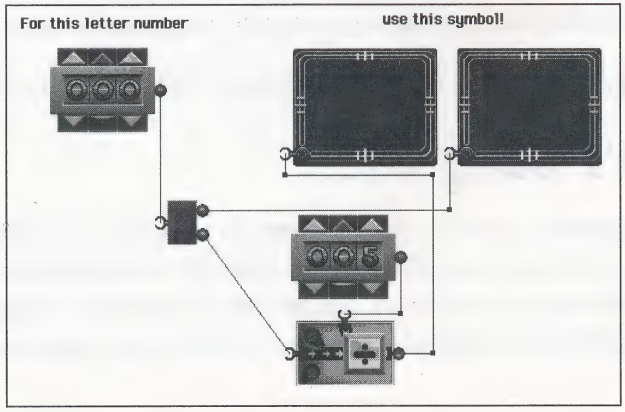
Get Set

1. Start by making a list of the letters in the alphabet. Next to each letter, write the corresponding number. For example, A = 1, B = 2, C = 3, and so on. Keep the list handy to use with the Secret Code Generator.

2. Now build the widget. Double-click on one of the Three-Digit Number parts, and set the Beginning Number to 5. Then click on the OK button.

3. Make sure the Graphic Projectors are set to the Phases of the Moon picture set. To do this, double-click on a projector, and select the Phases of the Moon option from the picture set list. Next, set both Graphic Projectors to Wrap Around Set. Click on the OK button when you're done.

4. Use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Write the message or letter you want to put in code.
2. Click on the GO button in the Control box.
3. Enter the number of the letter you want to translate into the Three-Digit Number part. You'll see two graphics appear. These two graphics represent the code for that letter. To write the code, draw the pictures for each letter. For instance, if you enter the number 10 for the letter J, you'll see two half moons. So, for every J in your message, you would draw two crescent moons.
4. Send the message in code to a friend. You may want to save the Secret Code Generator as a stand-alone widget, so your friend can decode the message you sent!

What's Going On?

There only 8 pictures in the Phases of the Moon picture set, but there are 26 letters in the alphabet. To make different combination of pictures for each letter, this widget generates two different numbers for every number you enter. The first number is divided by 5, so that there will be 6 possible pictures for the first picture, and 8 possible pictures for the second picture. So, in fact, you could have a total of 48 different codes if you wanted to.

Binary Number Translator

Your computer may do a lot of things that seem amazing, but what's really incredible is that it does all its calculating and music making and word processing using only two numbers: 1 and 0. These two numbers make up the Binary System. Everything the computer reads—numbers, letters, and special symbols—are translated into the binary system. This widget does the reverse—it lets you translate numbers from the binary system into regular decimal numbers.

Get Ready

You'll need the following parts from the Parts Bin:

- 5 Three-Digit Displays
- 5 Three-Digit Numbers
- 5 Multipliers
- 5 Two-way Splitters
- 1 Ten-Digit Display
- 4 Adders
- 5 Light Switches
- Sticker (optional)

Get Set

1. Set the Three-Digit Number parts as follows:

   1 part = 16

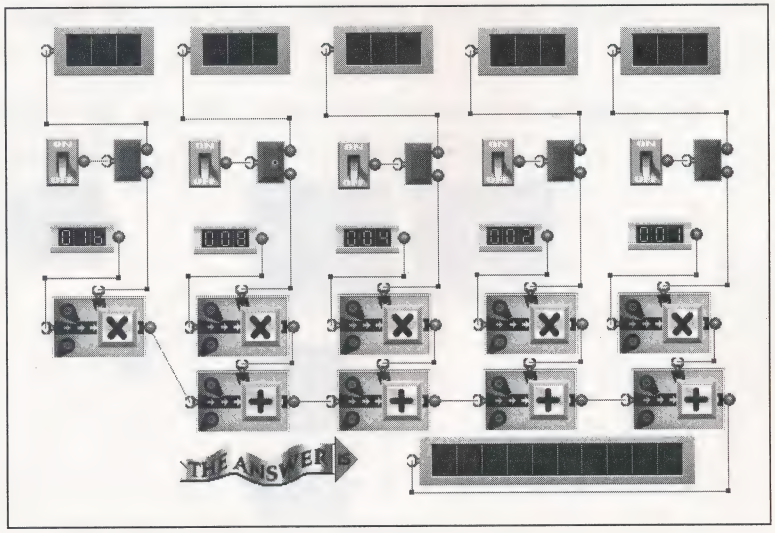
   1 part = 8

   1 part = 4

   1 part = 2

   1 part = 1

2. Use the mouse to arrange the parts and connect them so they look like this:



Go

1. Click on the GO button in the Control box.
2. Click on the Light Switches to enter in a binary number. Each Light Switch corresponds to a particular place value. For example, to enter in the number 101, you would click on the Light Switch that is on the right, and on the Light Switch that is third from the right. You'll see the binary number in the Three-Digit Displays on top, and the decimal number in the Ten-Digit Display at the bottom.
3. Try a variety of binary numbers in the translator. What does the binary number 1010 translate to in decimal? What about 11111? What about 10?

What's Going On?

Unlike decimal place values, which increase by a power of ten (1, 10, 100, and so on), binary place values increase by a power of two (1, 2, 4, 8, etc.). Adding up the value of the places marked by binary 1s gives the decimal number. For example, to convert 101 to a decimal, you would add one 1 (from the first place value) plus zero 2s (from the second place value) plus one 4 (from the third place value). Thus, 101 in binary equals 5 in decimal.

Fast Math Game

Here's a math game that lets you test your math skills and your reflexes.

Get Ready

You'll need the following parts from the Parts Bin:

- 3 Three-Digit Displays
- 2 Speakers
- 2 Random Number Generators
- 3 Keypresses
- 5 Two-way Splitters
- 2 Billboards
- 2 Animals Sounds
- 1 Multiplier
- 1 Light Switch
- 1 Switcher
- Labels

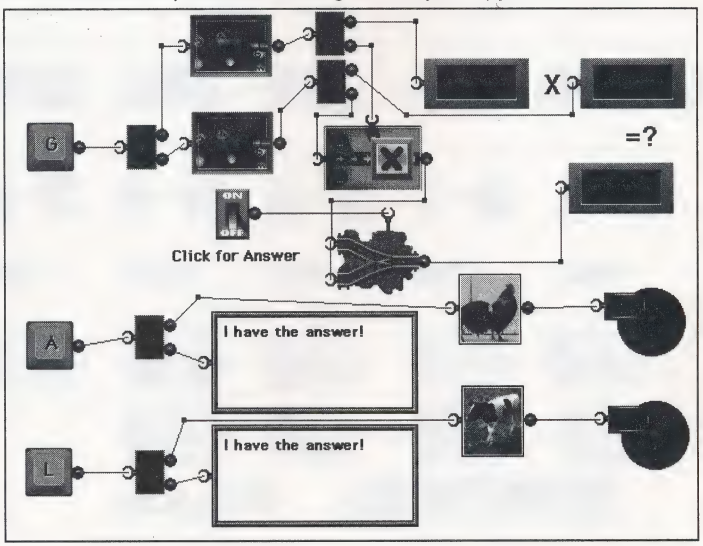
Get Set

1. Change the letters for the Keypress parts, so that one Keypress responds to the letter G, one responds to the letter A, and one responds to the letter L.

2. Double-click on one of the Animals Sounds parts, and pick an animal noise for yourself. Then click the OK button. Double-click on the other Animal Sounds part and choose an animal sound for your opponent. Click on the OK button.

3. Open the information box for a Billboard by double-clicking on the part. Type in the message "I have the answer!" Then click on the OK button to close the box. Do the same for the second Billboard part.

4. Next, use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.
2. Place one finger on the A key, while your friend places his or her finger on the L key.
3. Press the G key to start the game. Two numbers will appear in the top Three-Digit Displays. The player who thinks he or she knows the product of the two numbers should press his or her key as soon as possible. When a player presses his or her key, the billboard message will appear and that player's animal sound will be heard. The player should say the answer out loud. Click on the light switch to see if the answer is correct.
4. Click the Light Switch back to the off position.
5. Press the G key again to display another math problem. See who can get the most right answers in a certain period of time.

What's Going On?

This widget creates two random numbers that are used for the math problem. You can change the selection of numbers by double-clicking on a Random Number Generator and changing the range so that it's smaller or larger. You can also make the problems as difficult as you would like by changing the math functions that you use in the problem.

Doc's Widget Workshop Challenge!

Try adding a counter to this widget so you can keep track of the score!

Guess It Game

This solitaire number guessing game includes a timer made from the Gravity Chamber part.

Get Ready

You'll need the following parts from the Parts Bin:

- 2 Light Bulbs
- 1 Random Number Generator
- 1 Keypress
- 2 Two-way Splitters
- 1 Gravity Chamber
- Labels
- 2 Three-Digit Numbers
- 3 Comparers
- 1 Switcher
- 2 Three-way Splitters
- 2 Win/Lose Checkers
- Sticker (optional)

Get Set

1. Set one Comparer to be Greater Than by double-clicking on the part and choosing the Greater Than option. Set the second Comparer to the Less Than option, and set the third Comparer to the Equal To option.

2. Next, change the range of the Random Number Generator so it produces numbers from 1 to 20. To do this, double-click on the part. Choose the Custom Range option, and type a 1 in the first box and a 20 in the second box. Then click the OK button.

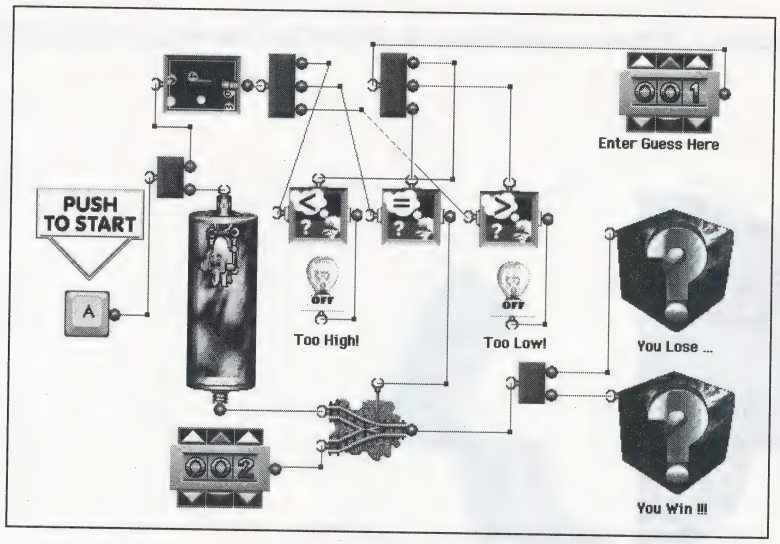
3. Double-click on one of the Win/Lose Checkers. Make sure it is set so that it says "Win/Lose if input is equal to (=) 1". Then click the Lose Sound option at the bottom of the information box. Click on OK to close the box.

4. Double-click on the second Win/Lose Checker. Change the settings so it says "Win/Lose if input is greater than (>) 1". Then click on the Win Sound option at the bottom of the box. Click on OK when you are done.

5. Set one of the Three-Digit Numbers so it has a Beginning Number of 2. Click on the Lock Number option so you don't accidentally change the number.

6. Double-click on the Gravity Chamber. Make sure the Output setting on the right is set to On When Hits. Then click the OK button.

7. Finally, use the mouse to arrange the parts, then connect and label them so they look like this:



Go

1. Click on the GO button in the Control box.

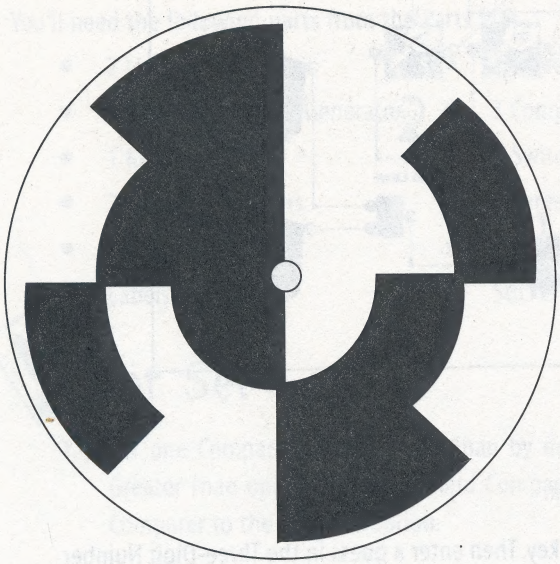
2. When you're ready to play, click on the A key. Then enter a guess in the Three-Digit Number part at the top. If your guess is too low, the Too Low light will go on. If your guess is too high, the Too High light will go on. If you guess the number correctly before the elephant gets to the bottom of the gravity chamber, you win!

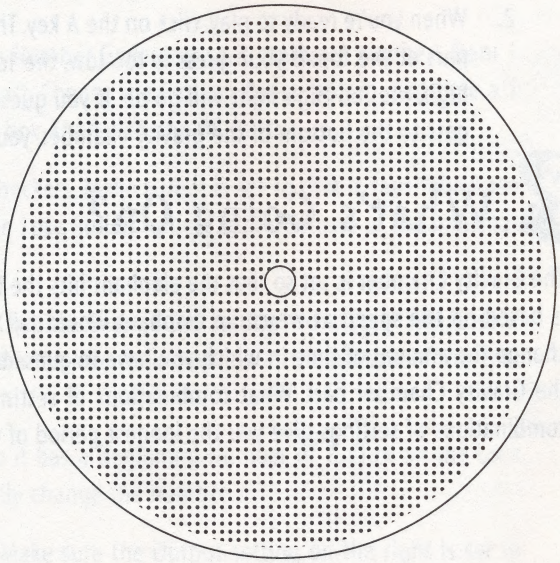
What's Going On?

The Gravity Chamber is set so that the elephant hits the bottom after a certain amount of time. That time is based on the speed at which an elephant would fall from a given height at a given gravity. You can change the amount of time in which you have to guess by changing the setting for gravity and height in the Gravity Chamber part. What combinations of settings give you the shortest period of time? What combinations of settings give you the longest period of time?

Spinning Disk Patterns

Copy these patterns, cut them out and put them on the wooden top to see what optical illusions they produce.





MAXIS
SOFTWARE TOYS FOR KIDS

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0038-000-0136-B

Maxis Maxims

The Maxis Guarantee

We want you to be happy. We do our best to make software that is both fun and trouble-free, but if there is a problem, let us know. If you are not completely satisfied with your purchase, for any reason, you should first consult the return or exchange policy at the place of purchase. If all else fails, you may exchange it for a different Maxis catalog product of equal or lesser value. Just send back the program to the address below, with your dated sales receipt within 30 days of purchase and a check or money order for $5.00 to cover return freight, and specify your choice of product for exchange. If the exchange order amount is higher than your return credit please include the additional payment. Dealers and Distributors are not eligible.

Disk Warranty

Maxis provides a 90-day limited warranty on the recording media. For disk replacement contact Maxis Customer Service or Technical Support.

Maxis Customer Service

For the location of your nearest software retailer, exchange information, software updates, warranty disk replacement, catalog orders, direct order status, shipping information or general stuff contact Maxis Customer Service at 510-254-9700, M–F 8:00am–5:00pm (Pacific Time), or by Fax at 510-253-3736, or by mail at Maxis Customer Service, 2 Theatre Square, Orinda, CA 94563-3346.

Maxis Technical Support

For technical questions dealing with hardware and software compatibility, startup problems, system errors and other unexplained phenomena, refer to your manual addendum. If the problem persists, then follow these directions before contacting Technical Support: 1) Gather all information that applies to the problem. Note or print out any onscreen error messages you get when the problem occurs. 2) Write down all of the steps that you have taken to correct the problem, along with any error messages the computer has given you. 3) Be sure that you know your hardware configuration, operating system version, memory, monitor type, etc. 4) When you call, please be in front of your computer with the power on. Have your manual, product disks and registration number available and contact Maxis Technical Support by calling: 510-253-3755 (M–F 8:00a.m.–6:00p.m.* Pacific Standard Time), or by Fax at 510-253-3736, or by mail at Maxis Technical Support, 2 Theatre Square, Orinda, CA 94563-3346.

*Customer Support hours are subject to change.

The Maxis Bulletin Board Service (BBS)

You can reach the Maxis BBS via modem at 510-254-3869. It provides on-line access to the latest software demos, updates, extra files, swap-able files, and the Technical Support message base. There is no charge for Maxis BBS usage, and full user access is granted upon completion of a brief questionnaire. We run at 14,400 and all lower baud rates and require a setting of 8 data bits, no parity and 1 stop bit (8-N-1).

We Also Provide On-Line Support on the Following Subscription Services:

America OnLine: Keyword "Maxis"; E-Mail "Maxis". AOL can be obtained by calling 1-800-827-6364 and asking for a free introductory sign-on kit. Five hours of free time are provided with the first month.

CompuServe: Go "gambpub" and select "Maxis"(section 8); CompuServe can be obtained by calling 1-800-524-3388 and asking for operator #420 to receive a free introductory membership, $15 usage credit, and a month's worth of basic services free.

GEnie: Scorpia's Roundtable, Maxis Area; E-Mail "Maxis". GEnie can be obtained by calling 1-800-638-9636. There is no initial sign-on fee.

Apple Link: E-Mail "D4459".

Prodigy: E-mail address is MAXI99A.

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